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(54) **BLENDER BLADE**

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(51) **Int. Cl.**[7] **A47J 43/046**
(52) **U.S. Cl.** **241/282.1**; 366/205
(58) **Field of Search** 241/282.1, 282.2, 241/292.1; 366/205, 343

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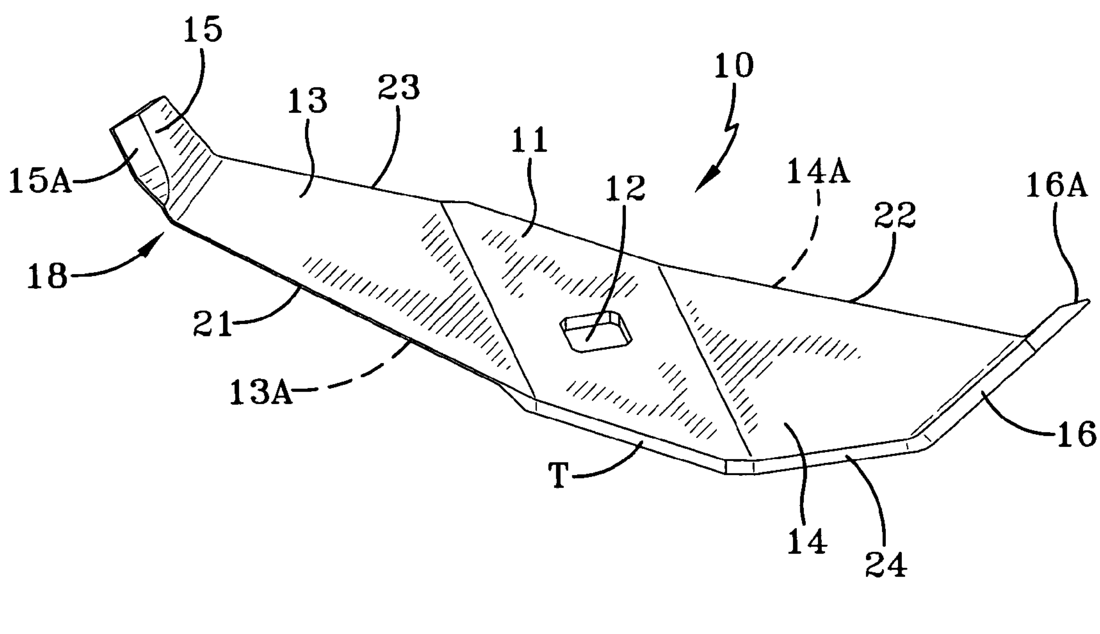
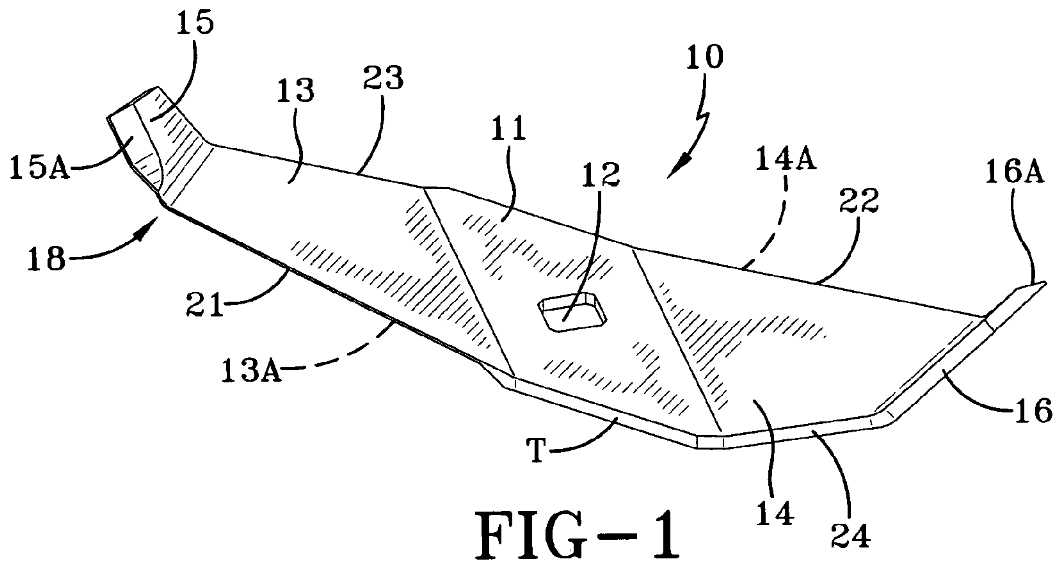
(57) **ABSTRACT**

A blade (**10**) for a blender includes a center portion (**11**) which includes the axis of rotation. Blade wings (**13, 14**) extend outwardly from the center portion (**11**) and wing tips (**15, 16**) are positioned at the end of the wings (**13, 14**). The wings (**13, 14**) and wing tips (**15, 16**) having leading edges (**21, 22**) and trailing edges (**23, 24**). The portion of the leading edges (**21, 22**) along the wings (**13, 14**) have beveled edges (**13A, 14A**) at the bottom surface thereof, and the portion of the leading edges (**21, 22**) along the wing tips (**15, 16**) have beveled edges (**15A, 16A**) formed at the top surfaces thereof. Each of the wings (**13, 14**) has an effective width to length ratio of greater than 0.287, the length being measured between the axis of rotation and the distal ends of the wing tips (**15, 16**).

7 Claims, 2 Drawing Sheets

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15A
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23
10
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14A
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16A
18
21
13A
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16
14
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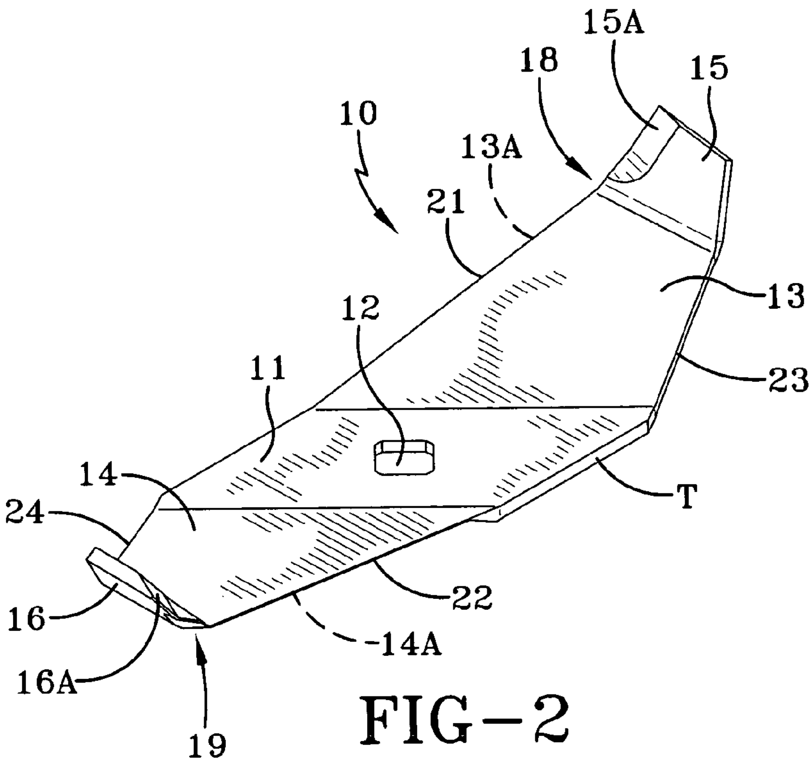
FIG-1


15A
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13A
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-14A
16A
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FIG-2

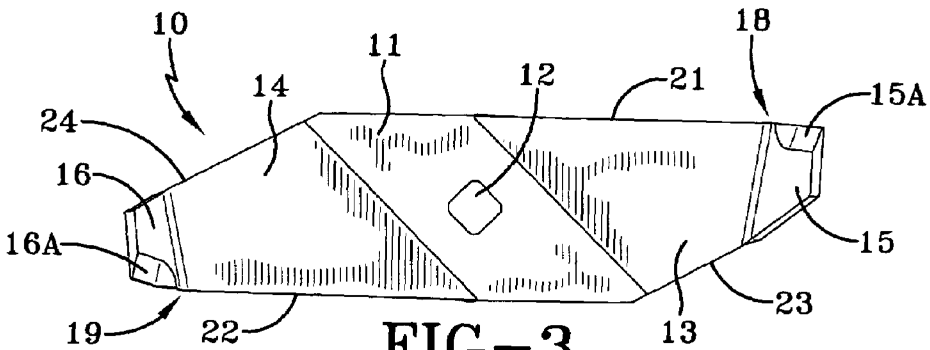

FIG-3

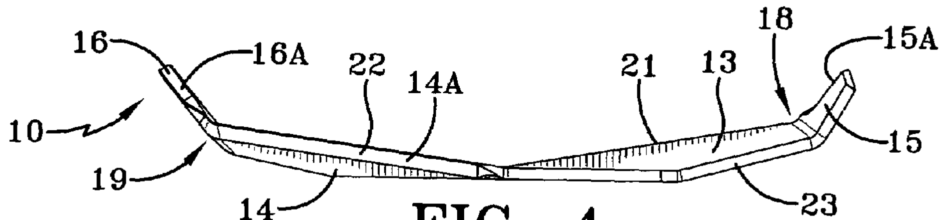

FIG-4

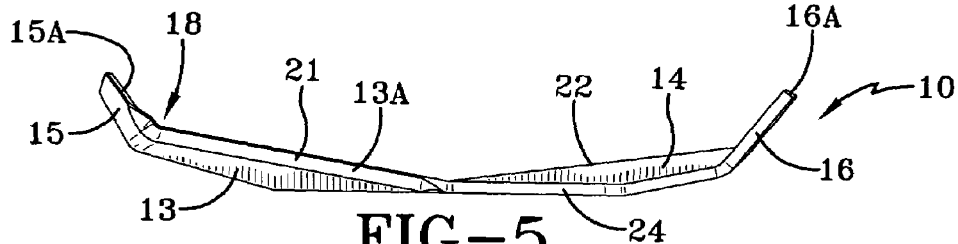

FIG-5

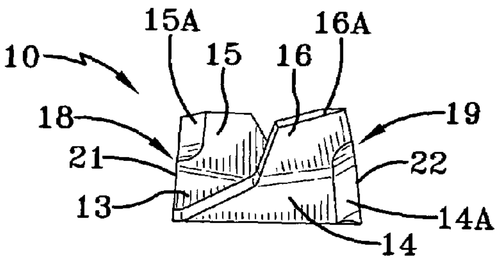

FIG-6

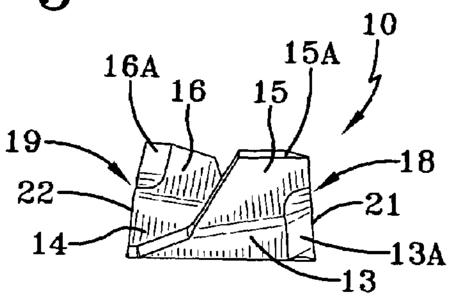

FIG-7

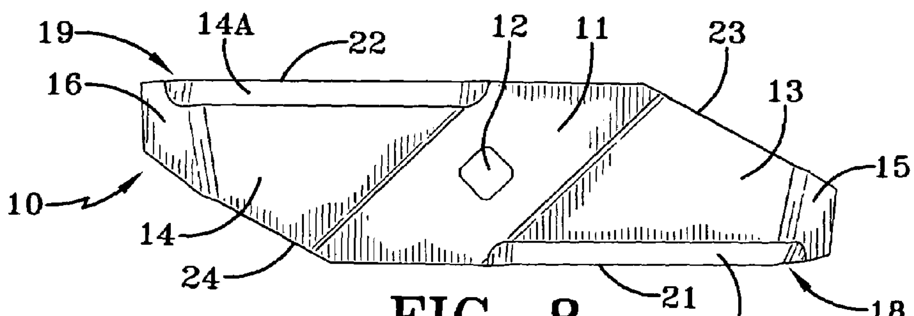

FIG-8

BLENDER BLADE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/471,439 filed on May 16, 2003.

TECHNICAL FIELD

The present invention relates generally to blades for blenders, and in particular, providing such blades with efficient configuration. More specifically, the present invention relates blender blades configured to optimize the relationship between the coefficient of drag (C_D) and the coefficient of lift (C_L). Still more specifically, the present invention relates to blender blades configured to decrease drag by decreasing the amount of impact provided by the wings of the blender blades on a blending medium, but, simultaneously, having dimensions which provide such blender blades with more than adequate lift.

BACKGROUND ART

Blenders have a limited amount of power that can be used to rotate the blades of such blenders in a blending medium. Generally, the blending medium includes both liquids and solids, and the purpose of a blender blade is to homogeneously mix the blending medium provided in a blender pitcher. A blender blade is configured to rotate about an axis of rotation, and normally includes two wings extending in opposite directions from a center portion. The leading edges of the wings are provided with cutting edges, and the wings are oriented at compound angles with respect to the center portion to provide the blender blade with a compound angle of attack.

As the blender blade rotates within the blending medium, the cutting edges define a cutting path, and the wings generate flow of the blending medium. Such flow can be characterized as a vortex which is used to blend the disseparate components of the blending medium together. The flow generated by the wings due to rotation of the blender blade draws the blending medium through the cutting path to homogeneously mix the blending medium, and grind any solids entrained therein using the cutting blades. For example, if the wings are twisted such that the leading edges are vertically oriented above the trailing edges, then rotation of the blender blade repeatedly draws the blending medium (including the solids) through the cutting path. As such, the rotation of the blender blade continuously draws the solids downwardly through the cutting path, and thereafter, pushes the solids upwardly along the interior surfaces of the blender pitcher. Consequently, the blending medium is homogeneously mixed because the solids are continually ground and mixed with remainder of the blending medium through rotation of the blender blade.

Because there is a limited amount of power available from commercial or household electrical receptacles, the efficiency of the blender blades is determined by the blender blades ability to generate flow to homogeneously mix the blending medium using the limited power available.

Oftentimes, the configurations of blender blades have inherent tradeoffs embodied therein. For example, to increase the amount of lift imparted on the blending medium, and increase the ability of a blender blade to draw the blending medium through the cutting path, the wings can be specially configured. As discussed above, the wings are

typically oriented at compound angles with respect to the center portion to provide the blender blade with a compound angle of attack. As such, each of the wings is twisted such that its leading edge is vertically oriented above its trailing edge, and angled such that its distal end is vertically oriented above the center portion. Up to a threshold, the greater the angles of the wings, and, most importantly, the twists of the wings, the greater the amount of lift associated with the blender blade.

However, increasing lift produces a tradeoff because a greater amount of viscous resistance is generated when the twists and angles of the wings are increased. For example, a greater amount of blending medium impacts the bottom portions of the wings when the wings are twisted and angled as such. The more viscous resistance generated by impact of the blending medium on the bottom portions of the wings, the more drag which is imparted on the blender blade. Drag decreases the efficiency of the blender blade by decreasing the amount of flow generated thereby given the limited amount of power available. As such, the amount of lift generated by the blender blade is directly related to the amount of drag imparted on the blender blade, and therefore, is directly related to the amount of flow generated.

Consequently, there is a need to configure blender blades to optimize the relationship of lift and drag to efficiently generate flow. Such blender blades should have wings configured to decrease drag by decreasing the amount of impact provided by the wings on a blending medium, but, simultaneously, have dimensions which provide such blender blades with more than adequate lift.

DISCLOSURE OF THE INVENTION

It is thus an object of the present invention to provide a blender blade that is capable of homogeneously mixing a blending medium containing liquids and solids.

It is another object of the present invention to provide a blender blade, as above, which can finely grind solids entrained in the blending medium.

It is still another object of the present invention to provide a blender blade, as above, having an optimized relationship between lift and drag to efficiently generate flow.

It is a further object of the present invention to provide a blender blade, as above, having increased efficiency in generating flow in order to homogeneously mix the blending medium using the limited power available.

These and other objects of the present invention as well as the advantages thereof over existing prior art forms, which will become apparent from the description to follow, are accomplished by the improvements hereinafter described and claimed.

In general, a blender blade made in accordance with the present invention includes a center portion defining the axis of rotation of the blade. Wings extend outwardly from the center portion, and wing tips are positioned on the ends of the wings. The wings and the wing tips include leading edges and trailing edges, where the portion of the leading edges along the wings include beveled edges formed from the bottom surfaces of the wings and the portion of the leading edges along the wing tips include beveled edges formed from the top surfaces of the wing tips.

In accordance with another aspect of the present invention, a blender blade includes a center portion defining the axis of rotation of the blade. Wings extend outwardly from the center portion, and wing tips are positioned on the ends of the wings. Each of the wings has an effective width and a length measured between the axis of rotation and the distal ends of the wing tips, the ratios of the effective widths to the lengths of the wings being greater than 0.287.

A preferred exemplary blender blade made in accordance with the present invention is shown by way of example in the accompanying drawings without attempting to show all the various forms and modifications in which the invention might be embodied, the invention being measured by the appended claims and not by the details of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top, left side perspective view of a blade for a blender made in accordance with the present invention.

FIG. **2** is a top, left side perspective view thereof taken at a different orientation;

FIG. **3** is a top plan view thereof;

FIG. **4** is a left side elevational view thereof;

FIG. **5** is a right side elevational view thereof;

FIG. **6** is a left end elevational view thereof;

FIG. **7** is a right end elevational view thereof; and

FIG. **8** is a bottom plan view thereof.

PREFERRED EMBODIMENT FOR CARRYING OUT THE INVENTION

A blender blade made in accordance with the present invention is indicated by the numeral **10** in the accompanying drawings. Blender blade **10** is positioned in the bottom center of a blender pitcher (not shown), and rotates about an axis of rotation during operation. As blender blade **10** rotates, the flow generated by the rotation of blender blade **10** homogeneously mixes a blending medium (containing liquids and solids) added to the blender pitcher. For example, rotation of blending blade **10** generates flow in the form of a vortex. The vortex draws the blending medium through the cutting path of blending blade **10** to homogeneously mix the blending medium, and also finely grind any solids entrained therein.

Blender blade **10** has a center portion **11** which lies in a plane substantially orthogonal to the axis of rotation. Center portion **11** is provided with an aperture **12** used for attaching blender blade **10** to the blender motor. Aperture **12** effectively defines the axis of rotation of blender blade **10**.

Extending outwardly at angles from center portion **11** are substantially flat wings **13, 14**. Wings **13, 14** are oriented at compound angles with respect to center portion **11**, and provide blender blade **10** with a compound angle of attack. As such, wings **13, 14** are twisted such that their respective leading edges **21, 22** are vertically oriented above their respective trailing edges **23, 24**, and angled such that their ends are vertically oriented above the center portion **11**. Up to a threshold, the greater the angles of wings **13, 14**, and, most importantly, the twists of wings **13, 14**, the greater the amount of lift associated with blender blade **10**.

Attached to the ends of each of wings **13, 14** are wing tips **15, 16**, respectively. During operation, the orientation of wing tips **15, 16** with respect to wings **13, 14** creates mini-vortex forces around the periphery of blender blade **10**. The mini-vortex forces created by wing tips **15, 16** aid the flow generated by the vortex created by the rotation of blending blade **10** to homogeneously mix the blending medium.

As discussed above, wing **13** and its blade tip **15**, and wing **14** and its blade tip **16**, are provided with leading edges **21, 22** and trailing edges **23, 24**, respectively. Center portion **11**, wings **13, 14**, and wings **15, 16** have a uniform thickness T. Leading edges **21, 22**, however, are sharpened by removing material from thickness T. For example, the portions of leading edges **21, 22** along wings **13, 14** are sharpened by respectively providing beveled edges **13**A, **14**A. The beveled edges **13**A, **14**A can be provided on either the top or bottom surfaces of wings **13, 14**, but are ideally provided by removing material from the bottom surface of wings **13, 14**. Moreover, the portions of leading edges **21, 22** along wing tips **15, 16** are sharpened by respectively providing beveled edges **15**A, **16**A. The beveled edges **15**A, **16**A can be provided on either the top or bottom surface of wing tips **15, 16**, but are ideally provided by removing material from the top surface of wing tips **15, 16**.

As seen in FIGS. **4** and **5**, where wings **13, 14** and wing tips **15, 16** are respectively interconnected, transitions **18, 19** are formed respectively between beveled edges **13**A, **14**A (provided on the bottom surface of wings **13, 14**) and beveled edges **15**A, **16**A (provided on the top surface of wing tips **15, 16**). The alternate placement of beveled edges **13**A, **14**A on the bottom and beveled edges **15**A, **16**A on the top advantageously increases the grinding capacity of blending blade **10**.

As blender blade **10** rotates, leading edges **21, 22** create a substantially conical-shaped cutting path, and define the effective working area of blender blade **10**. In the working area, the blending medium is homogeneously mixed, and the solids included in the blending medium are finely ground.

In addition to providing the necessary working area for finely grinding the solids, the above-described configuration can be configured to optimize the relationship between drag and lift generated by the rotation of blender blade **10**. Such optimization increases the efficiency of blender blade **10** by advantageously increasing the flow of the blending medium through the working area while simultaneously decreasing the amount of power required to rotate blender blade **10**.

Lift is imparted onto the blending medium by blender blade **10** due to the negative pressure above and the positive pressure below the blade generated by blender blade **10** as it rotates. Drag is imparted onto blender blade **10** by the blending medium due to the viscous resistance of the blending medium as blender blade **10** passes therethrough.

The amount of force generated by the drag and lift of a blender blade **10** can be determined using equations well known in fluid dynamics.

$$\text{Drag Force}=C_D\cdot\tfrac{1}{2}\rho V^2 A \tag{1}$$

$$\text{Lift Force}=C_L\cdot\tfrac{1}{2}\rho V^2 A \tag{2}$$

In Equations (1) and (2), p is the density of the blending medium, V is the velocity of blender blade **10**, and A is the combined surface area of wings **13, 14** and wing tips **15, 16**. According to Equations (1) and (2), the amount of drag and lift forces generated by blender blade **10** depend upon the coefficient of drag (C_D) and coefficient of lift (C_L) associated with blender blade **10**.

Both coefficients, C_D and C_L, are mathematically related, and depend on the configuration of blender blade **10**. For example, the coefficient of drag (C_D), and therefore, the drag force, depends on the compound angle of attack of wings **13, 14**, the sharpness of leading edges **21, 22**, and the thickness of wings **13, 14** and wing tips **15, 16**. The coefficient of lift (C_L), and therefore, the lift force, depends on the compound angle of attack and the combined surface area of wings **13, 14** and wing tips **15, 16**.

Wings **13, 14** are provided with low compound angles of attack to decrease drag by decreasing the amount of impact provided by wings **13, 14** on a blending medium. Therefore, rather having the blending medium substantially impacting the bottom surfaces of wings **13**, **14** during rotation of the blender blade **10**, low compound angles of attack of wings **13**, **14** decrease drag by decreasing the amount of such contact. Moreover, low compound angles of attack compel the blending medium to impact leading edges **21**, **22**, rather than the bottom surfaces of wings **13**, **14**, which serves to increase the grinding efficiency of blender blade **10**.

However, the relationship between the coefficients, C_D and C_L, is non-linear, and the coefficients, and hence the forces of drag and lift, can differ by orders of magnitude for when wings **13**, **14** of blender blade **10** are configured to have low compound angles of attack. Therefore, adjusting the compound angles of attack of wings **13**, **14**, and thereafter, relating the forces of drag and lift, is extremely difficult.

Instead, it has proved advantageous to concentrate on maximizing the drag and lift forces for given compound angles of attack of wings **13**, **14** by adjusting the dimensions of the combined surface area of wings **13**, **14** and wing tips **15**, **16**. For example, because the coefficient of drag (C_D) is not related to the combined surface area of wings **13**, **14** and wing tips **15**, **16**, and should be relatively constant for blender blades **10** having wings **13**, **14** with the same compound angles of attack, the relationship between the drag forces of blender blades **10** with different combined surface areas can be easily related. Moreover, the lift force (which is also dependent on the combined surface areas) can be empirically related to the flow rate generated by these different blender blades **10**. Therefore, blender blades **10** having different combined surface areas, but having wings **13**, **14** with the same compound angles of attack, can be compared to determine the ideal dimensions for blender blade **10** which optimize the relationship between drag and lift.

Through testing, the ideal dimensions of blender blade **10** have been determined. For example, blender blades **10** having differing combined surface areas were provided. The combined surface areas of the different blender blades **10** were related to one another by comparing ratios related to the dimensions of wings **13**, **14** of blender blades **10**. The ratio compared the effective width ($W_{effective}$) of one of wings **13**, **14** to the length of the same one of wings **13**, **14** and corresponding one of wing tips **15**, **16**. The length is determined from the axis of rotation to the distal end of one of wing tips **15**, **16**, and the effective width ($W_{effective}$) was determined using Equation (3).

$$W_{effective}=A_{WING}/L \qquad (3)$$

In Equation (3), the A_{WING} is the surface area of one of wings **13**, **14** and the corresponding one of its wing tips **15**, **16** combined, and L is the length from the axis of rotation to the distal end of the same one of wing tips **15**, **16**.

The above-discussed ratio was determined for each of the different blades **10**, and the flow rate for a constant speed of rotation generated by each of the different blender blades **10** was measured using a flow meter. From these flow meter measurements and ratios, it was determined that blender blades **10** having dimensions providing a ratio of greater than 0.287 optimized the drag and lift forces. Blender blades **10** having ratios of at least 0.287 provide combined surface areas which provide relatively low drag forces as related to the lift forces empirically associated with the measured flow rates.

As such, wings **13**, **14** can be configured to decrease drag by decreasing the amount of impact provided by wings **13**, **14** on a blending medium, but, simultaneously, provide such a blender blade **10** with more than adequate lift. As such, blender blades **10** having dimensions providing for a ratio of greater than 0.287, as discussed above, have a relatively low drag force as compared to lift force. Therefore, the drag and lift of the blender blade **10** are optimized to increase the efficiency of blender blade **10** by increasing the amount of flow, and decreasing the amount of power necessary to generate that amount of flow.

Thus, it should be evident that a blade constructed as described herein accomplishes the objects of the invention and substantially improves the art.

What is claimed is:

1. A blade for a blender comprising a center portion defining the axis of rotation of the blade, wings extending outwardly from said center portion, and wing tips positioned on the ends of said wings, said wings and said wing tips including leading edges and trailing edges, wherein the portion of said leading edges along said wings include beveled edges formed at the bottom surfaces of said wings and the portion of said leading edges along said wing tips include beveled edges formed at the top surfaces of said wing tips, and wherein each of said wings has an effective width and a length, the ratios of the effective widths to the lengths of said wings being greater than 0.287, wherein the length is measured between said axis of rotation and the distal ends of said wing tips, and the effective width is the surface area of one of said wings and one of said wing tips divided by the length.

2. A blade for a blender according to claim **1**, wherein the ratio of the effective width to the length of a said wing is greater than 0.290.

3. A blade for a blender according to claim **1**, wherein each of said wings includes one of said wing tips attached thereto.

4. A blade for a blender according to claim **1**, wherein said wings are oriented at compound angles of attack, said wings twisted such that said leading edges are vertically oriented above said trailing edges and angled such that the ends of said wings are vertically oriented above said center portion.

5. A blade for a blender according to claim **4**, wherein said leading edges extend from said wings to along said wing tips.

6. A blade for a blender comprising a center portion defining the axis of rotation of the blade, wings extending outwardly from said center portion, wing tips positioned on the ends of said wings, and leading edges and trailing edges provided along said wings and said wing tips, wherein each of said wings have a length and an effective width, the length being measured between said axis of rotation and the distal ends of said wing tips, and the effective width being the surface area of one of said wings and one of said wing tips divided by the length, the ratios of the effective widths to the lengths being greater than 0.287, wherein said wings are oriented at compound angles of attack, and said wings twisted such that said leading edges are vertically oriented above said trailing edges and angled such that the ends of said wings are vertically oriented above said center portion, wherein the portion of said leading edges along said wings include beveled edges formed at the bottom surfaces of said wings, and wherein the portion of said leading edges along said wing tips include beveled edges formed at the top surfaces of said wing tips.

7. A blade for a blender according to claim **6**, wherein said beveled edges provided along said wings and said wing tips create a substantially conical-shaped cutting path and define an effective working area for said blade.

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